A1

Existing Conditions

The Town of Amesbury's transportation system is one of the most important factors that influences the development of the community and impacts the overall quality of life. An effective evaluation of existing conditions requires an understanding of current traffic volumes, operations and geometric conditions. Equally important is an understanding of pedestrians and bicyclists in the area. The existing conditions evaluation documented below focused on weekday morning, evening, and Saturday midday peak hour traffic volumes, recent crash history along the corridor, and inventories of roadway and intersection geometry and pedestrian and bicycle accommodations. A summary of transportation deficiencies and needs is provided at the end of this chapter.

For the safety and capacity analyses, the following intersections were evaluated:

- Route 110 at I-495;
- Route 110 at Rocky Hill Road;
- Route 110 at Elm Street (signalized location);
- Route 110 at I-95; and
- Elm Street at Rocky Hill Road.

Although driveways to local business along Route 110 are not included as study area intersections, field observations of these locations were made to determine what, if any, impact they have on the overall transportation operations of the corridor.

Study Area Demographics

A review of study area demographics related to transportation was completed to determine origin and destination patterns for the town and the mode of transportation used most prevalently. These patterns will be used to help identify the trip distribution patterns of any new development chosen for the Golden Triangle parcel. In general, the Town of Amesbury grew only modestly between 1990 and 2000. The data show that a majority of Amesbury residents work in the Town itself or in neighboring Newburyport or Haverhill. Other than Town residents, the majority of those commuting to Amesbury reside in Salisbury and Newburyport.

Not surprisingly, over 90 percent of all Amesbury residents commute to work by automobile, with about 10 percent of these carpooling. About two percent walk and four percent work at home. The remaining transportation means include public transportation, motorcycle and bicycle. Table A1-1 summarizes the existing demographic data.

Table A1-1
Existing Demographics[1]

Demographic	Population
Total Population	**16,450**
Workers	**5,200**
Workers residing in Amesbury	2,000
Workers residing in Salisbury	300
Workers residing in Newburyport	200
Drive to work	92 percent
Work at Home	4 percent
Walk to work	2 percent

1 Based on 2000 US Census data.

Traffic Volumes

This section summarizes key traffic volumes in the study area. Annual average traffic data, along with typical weekly and daily data are presented to compare traffic trends and characteristics by year, by day-of-week, and by hour of the day.

Seasonal Adjustments

The Massachusetts Highway Department maintains a traffic count database for Average Annual Daily Traffic (AADT) on roadways throughout the Commonwealth. Information on seasonal fluctuation along certain roadways is also provided. In the Amesbury area, only count locations on I-95 and I-495 are provided by MassHighway. These data show that interstate traffic volumes can be as much as 30 percent higher during the summer months. This can largely be attributed to vacation traffic in Massachusetts and vacationers destined to Maine, New Hampshire, and Canada.

While some seasonal fluctuation in traffic volumes is expected along Route 110, a review of historic traffic data provided by the Merrimack Valley Planning Commission (MVPC) show a change of less than five percent during the summer. Additionally, traffic volume along Elm Street has declined over recent years.

Therefore, to present a conservative view of traffic operations in the study area and how these operations might be affected by development of the Golden Triangle, no seasonal adjustment was made.

Daily and Peak Hour Traffic Volumes

Looking at how traffic fluctuates over a typical day provides insight into when peak periods occur and the intensity of traffic occurring during the peak period. Automated traffic recorder (ATR) data from the three bridges in the study area were obtained for a typical day of the week to demonstrate hourly fluctuations. A summary of daily traffic volumes is provided in Table A1-2.

Table A1-2
Daily Traffic Volume Summary

Location	ADT [1]	Weekday Morning Peak Hour			Weekday Evening Peak Hour		
		Volume [2]	K Factor [3]	Dir. Dist. [4]	Volume	K Factor	Dir Dist
Elm Street, east of Stop and Shop Driveway	13,000	800	6%	63% EB	1,200	9%	66% WB
Route 110, east of Elm Street	42,000	2,600	6%	61% EB	3,200	8%	58% WB
Route 110, west of Elm Street	32,500	1,900	6%	56% EB	2,900	9%	56% EB
Route 110, west of Rocky Hill Road	34,500	2,100	6%	56% EB	2,600	8%	57% WB
Rocky Hill Road, north of Route 110	2,500	250	10%	63% SB	150	6%	61% SB

Note: Peak hour volumes are based on ATR data and may differ from peak hour volume networks
1. Daily traffic expressed in vehicles per day; peak period volume expressed in vehicles per hour
2. Peak hour volumes expressed in vehicles per hour
3. Percent of daily traffic that occurs during the peak hour period
4. Directional distribution of peak period traffic

In addition to daily ATR data, manual turning movement counts (TMCs) were conducted at all study area intersections for the morning, evening and Saturday peak periods. The resulting peak hour traffic volume networks are depicted in figures A1-1through A1-3.

Safety

To identify potential vehicle crash trends in the study area, reported vehicular crash data for the study-area intersections was obtained from MassHighway for the years 2002 through 2004, the most recent three-year history available. A summary of the MassHighway vehicle crash history is presented in Table A1-3.

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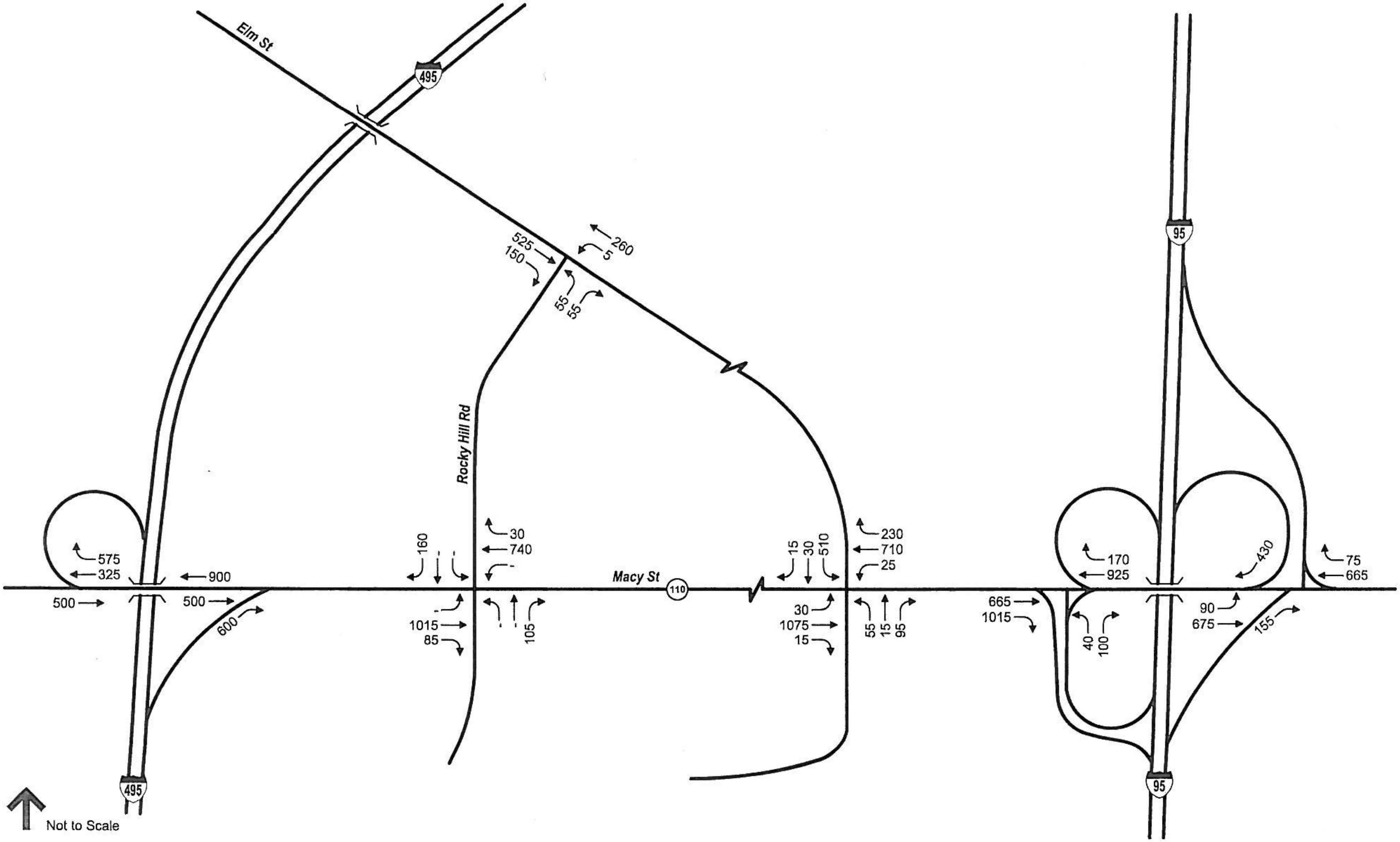

Vanasse Hangen Brustlin, Inc.

Figure A1-1

2006 Existing Weekday Morning
Peak Hour Traffic Volumes
Route 110 Economic Development Study
Amesbury, Massachusetts

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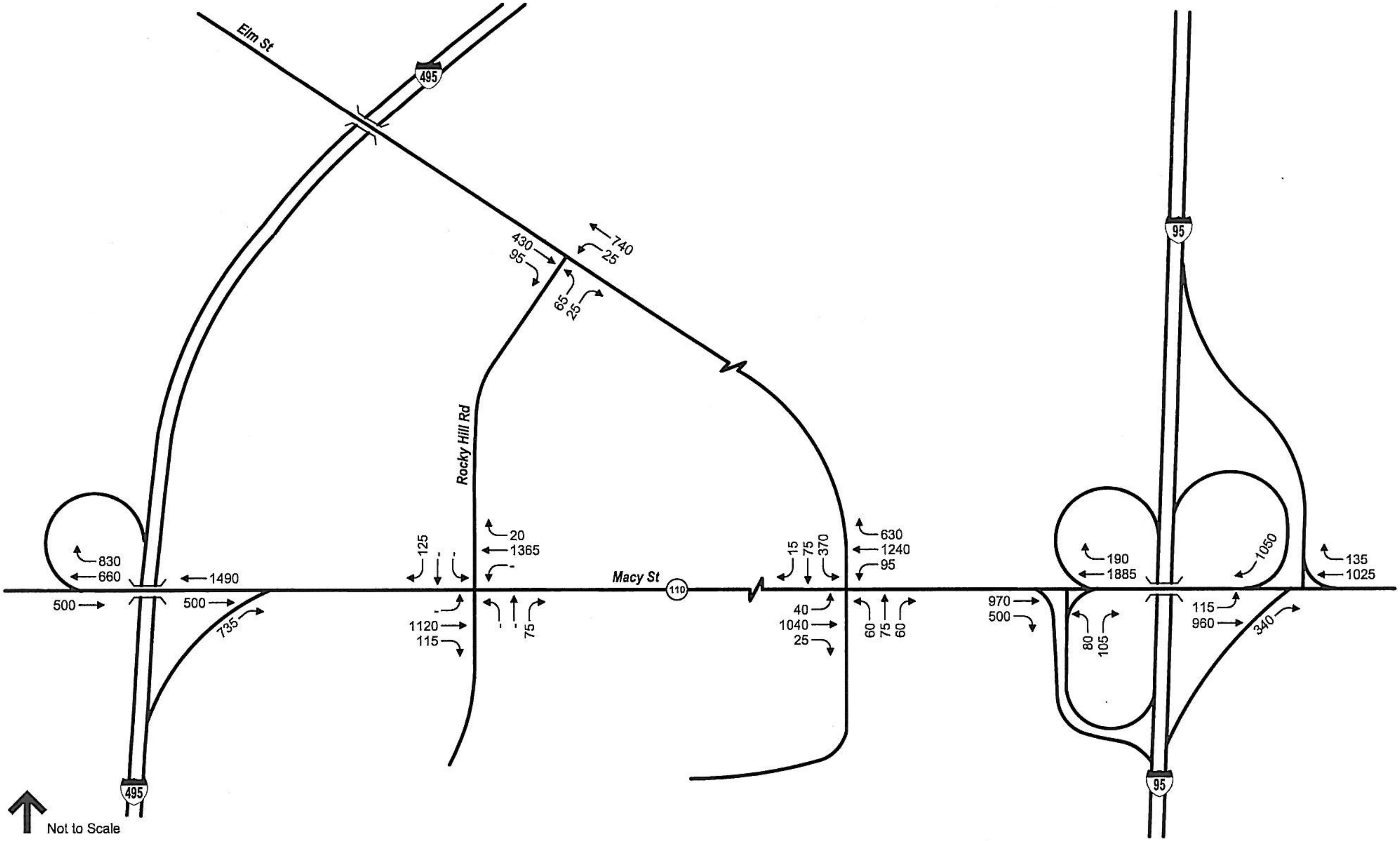

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Figure A1-2

2006 Existing Weekday Evening
Peak Hour Traffic Volumes
Route 110 Economic Development Study
Amesbury, Massachusetts

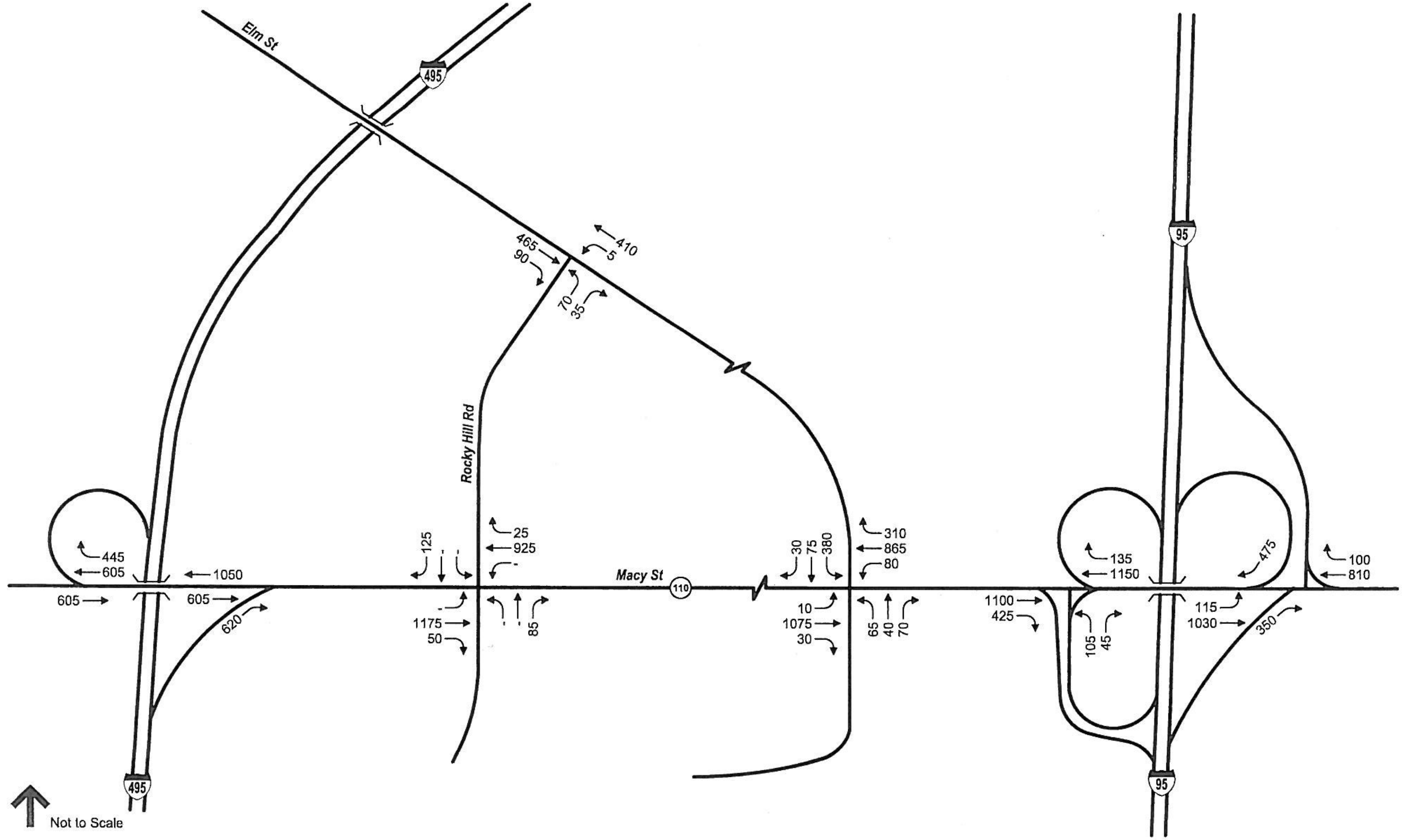

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Figure A1-3

2006 Existing Saturday
Peak Hour Traffic Volumes
Route 110 Economic Development Study
Amesbury, Massachusetts

The 2003 MassHighway average crash rates for signalized and unsignalized intersections for District 4, the MassHighway district designation for Amesbury, are 0.88 and 0.63, respectively. As shown in Table A1-3, none of the study area intersections exceed the MassHighway District 4 average crash rate values for the three year period between 2002 and 2004 and none of the intersections in the study area experienced any recorded fatalities between 2002 and 2004. However, the intersection of Route 110 and Elm Street is ranked 850 of 1,000 crashes on the MassHighway Department's Top 1000 High Crash Locations Report for the years 1999 to 2001. This compares favorably to a ranking of 242 on the published list for 1996 to 1998, indicating that the Town is taking necessary steps to improve safety at this location.

A total of 46 crashes occurred during the three year period with over half of these (27 crashes) occurring at the intersection of Route 110 and Elm Street. Of these 29 incidences, 11 were rear-end type crashes and seven were angle type crashes. The large number of rear-end type crashes could be an indication of inadequate clearance time (yellow-light time) during a traffic signal phase[1] or of a high number of drivers attempting to run a red light. This intersection and the immediately adjacent roadway has seen some physical improvement over the last several years and as a result the number of crashes has reduced significantly (from 58 during the 1999 to 2001 period to 27 during the 2002 to 2004 period). Further safety improvements to this intersection are anticipated as part of this study (see Chapter 4 for details).

A total of eight crashes occurred at the I-495 ramps and Route 110, and three crashes occurred at the I-95 ramps with Route 110. The MassHighway data does not distinguish between on and off ramps; therefore it is not possible to accurately calculate crash rates at these locations. Failure to yield or inadequate merging distance may be a contributing factor to these crash incidences. As this project moves forward, the Town will be presented with options to improve ramp safety.

[1] Highway Safety Engineering Studies Procedural Guide; United States Department of Transportation (USDOT); Washington, DC; June 1981.

Table A1-3
Vehicular Crash Summary (2002-2004)

	Route 110 at I-495 Ramps	Route 110 at Rocky Hill Road	Rocky Hill Road at Elm Street	Route 110 at Elm Street	Route 110 at I-95 Ramps
Signalized?	No	No	No	Yes	No
MassHighway Average Crash Rate	0.63	0.63	0.63	0.88	0.63
MassHighway Calculated Crash Rate	NA	0.13	0.18	0.60	NA
Year					
2002	3	0	2	12	0
2003	2	2	1	8	3
2004	3	3	0	7	0
Total	8	5	3	27	3
Collision Type					
Angle	1	2	2	7	0
Head-on	0	0	0	1	0
Rear-end	5	2	0	11	3
Sideswipe	0	0	1	5	0
Single-vehicle crash	1	1	0	2	0
Unknown	1	0	0	1	0
Total	8	5	3	27	3
Severity					
Injury	3	1	2	5	0
Property-related	5	4	0	21	2
Unknown	0	0	1	1	1
Total	8	5	3	27	3
Time of day					
Weekday, 7:00 AM - 9:00 AM	0	0	0	1	0
Weekday, 4:00 PM - 6:00 PM	0	1	0	2	0
Saturday, 11:00 AM - 2:00 PM	1	0	0	1	1
Weekday, other time	5	1	3	16	1
Weekend, other time	2	3	0	7	1
Total	8	5	3	27	3
Pavement Conditions					
Dry	6	3	2	21	3
Wet	2	1	1	4	0
Snow	0	1	0	0	0
Ice/Slush	0	0	0	1	0
Unknown	0	0	0	1	0
Total	8	5	3	27	3

Source: MassHighway Crash Database 2002-2004.

Traffic Operations

Understanding the relationship between the supply and demand on a roadway is a fundamental consideration in evaluating how well a transportation facility fulfills its objective to safely and efficiently accommodate the traveling public. The assessment of traffic operations provides a technical evaluation of the operational qualities of the key intersections using the procedures documented in the *2000 Highway Capacity*

Manual [2]. This section presents the details of the traffic operations assessment for the study area intersections.

Level of Service

Level of Service (LOS) is a qualitative measure used to describe operational conditions. Level of Service incorporates factors such as speed, travel time, freedom to maneuver, and traffic interruptions. Similar to a school report card, level of service is designated on levels A through F, with LOS A representing the best operating conditions and LOS F the worst.

When determining level of service, two key outputs are calculated, volume to capacity (v/c) ratios and average delay. Volume to capacity ratios are calculated for each lane group and for the intersection as a whole. Average delay is calculated for each lane, each approach, and the intersection as a whole.

Level of service is a measure of the delay incurred by motorists at signalized intersections. In some instances, poor progression or unnecessarily long signal cycle length will cause a high delay even though the v/c ratio indicates sufficient capacity. It is also possible to have acceptable delay when v/c ratios exceed 1.0. Because these conditions are possible, analysis should consider the results of both delay and v/c calculations.

Any v/c ratio greater than 1.0 is an indication of an actual or potential breakdown of traffic operations. In some cases, the overall v/c ratio will be less than 1.0 while some lanes of the intersection are greater than 1.0. When this is the case, signal timing can often be adjusted to restore operations to acceptable conditions. When a critical lane v/c ratio is greater than 1.0, it is likely that the overall signal and geometric design are inadequate to process the existing traffic. In these cases more comprehensive improvements may be necessary.

Method for Determining Level of Service

Several analytical software tools are used to determine LOS depending on the type of control at the intersection. SYNCHRO 6.0 software is used for signalized intersections and unsignalized intersections. The software uses inputs such as volumes, geometry, signal timing (if applicable), and pedestrian and parking maneuvers to assign a LOS rating.

The LOS procedure looks at the performance of the intersection on an hourly basis. The morning and evening peak hour periods are the two hourly intervals used to

[2] 2000 Highway Capacity Manual; Transportation Research Board, National Research Council; Washington D.C. 2000

determine an intersections LOS rating. Morning and evening peak hour traffic volumes and the geometric conditions at the key intersections are the key inputs to the software.

For signalized and unsignalized intersections, level of service is defined in terms of average control delay per vehicle. Control delay includes stopped time and the time required to decelerate, move forward in the queue, and accelerate. For unsignalized intersections, the analysis assumes that traffic on the main street is not affected by traffic on the side street and therefore estimates the level of service for left-turns from the main street onto the side street and for all movements from the side street. For signalized intersection, level of service is determined for all approaching movements.

The Highway Capacity Manual does not present a recommended LOS for design purposes; rather it offers a description of the conditions associated with each level of service. For example, LOS C is described in the manual as stable operating conditions. As conditions deteriorate to LOS D or E, the HCM describes conditions with words such as unstable flow. Level of Service E or LOS F are generally considered unacceptable conditions.

Results

The results of the existing conditions operations analysis are provided in Tables A1-4 to A1-6.

Table A1-4
Signalized Intersection Capacity Analyses

Location	Weekday Period	2006 Existing v/c [1]	Delay [2]	LOS [3]
Route 110 at	Morning	0.68	25	C
Elm Street	Evening	0.78	28	C
	Saturday	0.71	24	C

1 volume-to-capacity ratio
2 average delay in seconds per vehicle, rounded to the nearest whole second
3 level of service

As shown in Table A1-4, the only signalized intersection in the study area operates at an acceptable level of service during all study conditions. However, field observations indicate long queues sometimes add to congestion at this location. These queues could be better managed by adjusting the traffic signal coordination along Route 110 between the Elm Street intersection and the Stop & Shop driveway to the west.

Table A1-5
Unsignalized Intersection Capacity Analyses

Location	Movement	Weekday Period	2006 Existing Dem [1]	Del [2]	LOS [3]	Queue [4]
Route 110 at	WB R	Morning	575	0	A	0
I-495 SB on ramp	WB R	Evening	830	0	A	0
	WB R	Saturday	445	0	A	0
Route 110 at	NB R	Morning	600	30	D	267
I-495 NB off ramp[5]	NB R	Evening	735	48	E	396
	NB R	Saturday	620	36	E	303
Route 110 at	NB R	Morning	105	31	D	63
Rocky Hill Road	SB R	Evening	125	86	F	139
	NB R	Saturday	85	32	D	49
Rocky Hill Road at	NB L	Morning	55	19	C	27
Elm Street	NB L	Evening	65	48	E	81
	NB L	Saturday	70	19	C	28
Route 110 at	WB R	Morning	1,015	0	A	0
I-95 SB on ramp	WB R	Evening	500	0	A	0
(from west)	WB R	Saturday	425	0	A	0
Route 110 at	NB L	Morning	40	16	C	22
I-95 SB off ramp	NB L	Evening	80	54	F	166
	NB L	Saturday	105	74	F	162
Route 110 at	WB R	Morning	170	0	A	0
I-95 SB on ramp	WB R	Evening	190	0	A	0
(from east)	WB R	Saturday	135	0	A	0
Route 110 at	SB R	Morning	430	28	D	186
I-95 NB off ramp	SB R	Evening	1,050	>120	F	--
(to west)	SB R	Saturday	475	71	F	379
Route 110 at	NB R	Morning	155	14	B	37
I-95 NB off ramp	NB R	Evening	340	32	D	158
(to east)	NB R	Saturday	350	40	E	194
Route 110 at	EB L	Morning	90	10	B	9
I-95 NB on ramp	EB L	Evening	115	12	B	18
	EB L	Saturday	115	11	B	15

1 demand in vehicles per hour for unsignalized intersections; the demand applies to only the most critical street approach or lane group
2 delay of critical approach only, rounded to the nearest whole second
3 level of service of the critical movement
4 95th percentile queue in feet
5 Gap times altered to reflect in-field observations.

As shown Table A1-5, deficiencies currently exist at two of the I-95 ramps and at both Rocky Hill Road intersections. Vehicle queues extending along the I-95 northbound off ramp are significant and could back on to the highway on occasion. As the study progresses, mitigation measures necessary to sustain the expected development will be identified.

Roadway Capacity Analysis

Roadway analysis aids in further identifying traffic flow constraints in the study area under future conditions. Traffic operating conditions along various sections of study area roadways were evaluated using standard analysis procedures. The evaluation criteria used to analyze critical roadway segments are based on the 2000 Highway Capacity Manual[3]. Roadway analysis takes into account a number of factors, including volume, lane width and the width of shoulders, general terrain features (level roadway or rolling hills), vehicle speeds, and the variety of the vehicles traveling along the corridor.

Important to note in the evaluation of two-lane roadways is the volume-to-capacity (V/C) measurement. V/C is a measurement of how many vehicles are traveling along the roadway versus the theoretical maximum number of vehicles that could be traveling along it[4]. For example, a V/C ratio of 0.50 indicates that the roadway is carrying 50 percent of its theoretical available capacity. Generally, a V/C ratio of 0.75 is considered the effective capacity of a roadway. For multilane roadways, where there is more than one lane in each direction, density is the primary performance measure for estimating LOS. Density is a measure of passenger cars per mile per lane. In conjunction with density, speed and flow or volume are also factors in determining LOS for multilane roadways. The three factors are interrelated such that when density decreases, the speed and flow rate increase, resulting in a better LOS.

Similar to the intersection capacity analysis, roadway segment analysis was performed along Route 110 and Elm Street. Table A1-6 presents the results of the roadway segment capacity analysis under existing conditions. Elm Street and Route 110 between Elm Street and Rocky Hill Road are two-lane roadways and LOS is presented for the overall roadway. However, Route 110 between Elm Street and the I-95 Ramps is a multilane roadway and LOS is summarized by direction. As shown in Table A1-6, both Elm Street and Route 110 between Elm Street and the I-95 Ramps operate at acceptable LOS under all time periods. While operating at an acceptable LOS during the morning peak period, Route 110 between Elm Street and Rocky Hill Road operates at LOS E under evening and Saturday peak conditions.

[3] Transportation Research Board, *Highway Capacity Manual*, Special Report 209, Washington DC, 2000.
[4] v/c calculations and theoretical comparisons are performed in accordance with the methodology presented in the 2000 Highway Capacity Manual.

Table A1-6
Roadway Segment Capacity Analyses

Location	Weekday Period	2006 Existing Hourly Volume	LOS[1]
Elm Street between	Morning	820	C
Route 110 and	Evening	1225	D
Rocky Hill Road	Saturday	900	C
Route 110 between	Morning	1890	D
Elm Street and	Evening	2490	E
Rocky Hill Road	Saturday	2065	E
Route 110 between	Morning		
Elm Street and I-95 Ramps	*Eastbound*	1680	C
	Westbound	965	B
	Evening		
	Eastbound	1470	B
	Westbound	1965	C
	Saturday		
	Eastbound	1525	B
	Westbound	1285	B

1 level of service

Weaving

The analysis of weaving operations at exit ramps is based on the methodology presented in Chapter 24 of the 2000 Highway Capacity Manual. A weaving segment is defined as the interaction between the crossing of two or more traffic streams traveling in the same direction without the aid of traffic control devices. The measure of effectiveness to determine the level of services is based on many parameters, including density and the speed of both the weaving and non-weaving vehicles. The higher the speeds and lower the density, the better the operations of the weaving segment. There is one weaving segment along Route 110 between the I-95 north and southbound ramps. As shown in Table A-7, this segment currently operates at an acceptable level of service.

Table A1-7
Weaving Segment Capacity Analyses

Location	Weekday Period	2006 Existing Density [1]	LOS [2]
Route 110 between	Morning	15.6	B
I-95 NB off ramp to west and	Evening	33.5	D
I-95 SB on ramp from east	Saturday	16.7	B

1 weaving segment density in pc/mi/la (passenger cars per mile per lane)
2 level of service

Queues

Vehicle queues were calculated for the existing conditions scenario using the capacity analysis results described earlier in this chapter. In locations where the v/c ratios are greater than 1.0, the queues are reported for comparison purposes although the queues are not accurately modeled for these conditions. These queues are denoted by "#" in the tables below. As shown in Tables A1-8 and A1-9, many of the existing condition queue lengths suggest minor to moderate delay impacts at study area intersections, but are not unusual for an area such as Amesbury. The exception is the I-95 northbound off-ramp queue (currently estimated at 2,264 feet), which greatly exceeds the distance of the off-ramp. As traffic volumes rise and the condition worsens this ramp could queue onto I-95 during many periods of the day.

Table A1-8
Signalized Queue Analyses

Location	Movement	2006 Existing Queue Length[1] Morning	Evening	Saturday
Route 110 at	EB L	43	51	21
Elm Street	EB T	378	339	371
	WB L	38	#105	88
	WB T	224	#504	265
	WB R	38	150	48
	NB L	70	72	80
	NB T	56	#157	#78
	SB L	#298	210	#222
	SB T	#298	214	#221

1 95th percentile queue in feet
95th percentile volume exceeds capacity, queue may be longer. Queue shown is maximum after two cycles.

Table A1-9
Unsignalized Queue Analyses

Location	Movement	2006 Existing Queue Length[1] Morning	Evening	Saturday
Route 110 at Rocky Hill Road	NB R SB R	63 68	49 139	49 64
Elm Street at Rocky Hill Road	NB L	27	81	28
Route 110 at I-495 NB off ramp	NB R	267	396	303
Route 110 at I-95 SB off ramp	NB L	22	166	162
Route 110 at I-95 NB off ramp (to west)	SB R	186	2,264	379
Route 110 at I-95 NB off ramp (to east)	NB R	37	158	194
Route 110 at I-495 SB on ramp	WB R	0	0	0
Route 110 at I-95 SB on ramp (from west)	WB R	0	0	0
Route 110 at I-95 SB on ramp (from east)	WB R	0	0	0
Route 110 at I-95 NB on Ramp	EB L	9	18	15

1 95th percentile queue in feet

Transit, Pedestrian and Bicycle Accommodations

There are currently limited existing transit, pedestrian and bicycle accommodation within the study area. Local bus service connecting Amesbury with the neighboring communities of Haverhill and Newburyport is provided via the Merrimack Valley Regional Transit Authority (MVRTA). Additionally, C&J Bus Lines provide service to Boston and regional points north and south from the park and ride facility on I-95 in Newburyport. Commuter Rail service to Boston's North Station is also provided from Newburyport. More detailed information about transit options can be found in the Amesbury Master Plan.

Narrow shoulders are provided along Route 110 and Elm Street and provide limited bicycle accommodation. Sidewalks are provided on Route 110 in front of the Stop & Shop supermarket and adjacent to the I-95 northbound ramps. The only crosswalk across Route 110 is provided at the intersection of Route 110 and Elm Street. No crosswalks are provided across Elm Street in the study area. Sidewalks are provided on Elm Street to the north of the study area.

There are currently no on-road bicycle facilities in Amesbury; however the Town has begun construction of the Powow Riverwalk and Bicycle Path along the Powow River, with eventual connections to the downtown area planned. Through the study area, the Town is currently considering a path along the abandoned railroad right-of-way to connect downtown Amesbury with paths in Salisbury.

Summary of Existing Deficiencies/Needs

Safety or operational deficiencies currently exist at four study area locations:

- Route 110 at Elm Street (safety deficiency);
- Route 110 at I-95 ramps (during all peak hours operational deficiencies);
- Route 110 at Rocky Hill Road (evening peak hour operational deficiencies); and
- Rocky Hill Road at Elm Street (evening peak hour operational deficiencies).

As traffic volume increase over time, the intersection deficiencies will worsen. The build scenarios identified as part of this study will provide guidance on ways to improve safety and intersection operations throughout the study area.

Bicycle and pedestrian accommodations through the study area are also deficient. Any development plan considered by the Town should include ways to attract pedestrian and bicycle activity as well as planned infrastructure to accommodate them.